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A communication device

Field of the invention

The invention relates to a communication device comprising a housing enclosing at least one loudspeaker and at least a part of at least one antenna inside the housing, said at least one loudspeaker comprising an acoustic resonance chamber and said at least one antenna comprising at least one electromagnetic resonance chamber.

Background of the invention

Communication devices such as handheld cellular phones have gained widespread acceptance over the years. One reason for this is the constant development of new generations of communication devices with smaller dimensions than the previous one making the communication device handier in use and more convenient to carry.

In the field of this invention a conventional communication device comprises two volumes of interior space used as resonance chambers where the loudspeaker uses the first volume and the other volume is used by the antenna.

A problem of the conventional communication device is to make it even smaller yet or at least maintain the size even though the communication device has to contain more

and more electronic components to be able to give more new features.

Summary of the invention

When as stated in claim 1 the acoustic resonance chamber is totally or partly located within the electromagnetic resonance chamber it is possible to build the communication device considerable smaller than the conventional types with separately resonance chambers for the antenna and loudspeaker.

At the same time volume needed for walls to encapsulate two resonance's chambers can now be reduced to the walls surrounding the shared resonance chamber.

It should be noted that the acoustic resonance chamber according to the invention e.g. may be a closed pressure chamber or a partly closed a bass reflection chamber adapted to obtain a desired frequency characteristic and efficiency. The main component providing this feature in a pressure chamber loudspeaker is the air encapsulated by the walls defining the chamber and the membrane. The encapsulated air will accordingly act as an elasticity, defined with the art as c_m. Of course the resonance according to the invention can also comprise a bass reflection design, in which especially the lower frequency of the loudspeaker system is modified by the adding of at least one opening from the internal of the loudspeaker chamber to the external.

The meaning of an acoustic resonance chamber is well described within the art of loudspeakers.

It should moreover be noted that an electromagnetic resonance chamber according to the invention is defined as at least some of the volume between at least a radiant part of an antenna and a ground plane or reference of said antenna. The said electromagnetic resonance volume has a specific dielectric constant and it is arranged within the housing of the device.

It is understood that the electromagnetic resonance volume may comprise completely of air or a combination of air and a dielectric material.

The meaning of an electromagnetic resonance chamber is well described within the art of antennas.

According to the teaching of the invention the above resonance may be shared more or less extensive, as the two different resonance phenomena's may be established independently of each other. No interference or distortion will occur, as the low frequency acoustic pressure wave resonance will be of a completely other nature than the electromagnetic resonance within the antenna resonance chamber.

Another important feature of the invention is that the desired electromagnetic performance of the antenna resonance chamber may be established fully or partly in air, as the dielectric properties of air may fully

satisfy the desired dielectric properties between e.g. the radiant plane and the ground plane of a patch antenna. Moreover, the desired conditions may be obtained by a combination of a solid dielectric and a gas dielectric, i.e. air. This possibility of designing a dielectric resonance chamber as a combination of air and solid dielectric, or completely constituted by air, results in a significantly increased freedom when designing the device. The solid dielectric according to the invention may e.g. be different kinds of plastics known within the art.

Due to the nature of the acoustic resonance chamber, the design of the internal shape of the chamber is of very little importance.

The communication device of the invention is preferably a mobile communication device or a handheld cellular phone.

Thus, according to the invention, the electromagnetic and the acoustic resonance chamber shares certain amount of air, having both the desired acoustic and dielectric properties.

Consequently a reduction of weight and of course material expenses is enabled, as the dielectric that was used to fill the volume inside the antenna may now be replaced by air.

When, as stated in claim 2, at least one antenna is a directive patch antenna, it is possible to control the radio waves direction from the antenna.

It should be noted that a directional patch antenna requires relatively high resonance volume, i.e. resonance volume between the radiant part of the antenna and the ground plane in order to obtain a satisfactory bandwidth. The possibility of establishing a shared volume between the acoustic resonance chamber and the electromagnetic resonance space of the antenna provides the possibility of obtaining a significant reduction in volume. It should be noted that even an apparently minor reduction in volume of a communication device may be significant, when an effective reducing of volume of e.g. 1 to 5 cm^3 is obtained in a 100 cm^3 mobile phone.

When, as stated in claim 3 that at least one antenna is a dual band antenna, it is possible to reduce the even more strict design criteria's, as the resonance volume will tend to occupy even more volume of the device.

When, as stated in claim 4, at least one antenna totally or partly defines the walls of the acoustic resonance chamber, it is possible to use the antenna to its main purpose as well as constituting some of the walls of the resonance chamber.

The antenna components such as ground plane and radiant plane may be supported in a great variety of chamber designs, as the volume required for the acoustic

resonance chamber usually will be significantly less than the required volume of for instance a micro-strip antenna.

Of course it should be kept in mind that the chamber defining materials, except of the active antenna planes should have a dielectric constant being somewhat comparable with the air inside the chamber. At least it should be designed such that the overall obtained resulting dielectric properties meet the desired requirements.

When, as stated in claim 5, the loudspeaker is coupled to the acoustic resonance chamber by at least one acoustic channel, a free opportunity of arranging the loudspeaker anywhere inside the housing of the communication device is achieved. This, of course, is under consideration to the limitations, which are in connection with using acoustic channels e.g. length and diameter of the channel. These limitations are well described within the art of acoustics and more specifically the design of acoustic channels.

This facilitates a somewhat easier design process of the communication device, which is of essential importance because of the very notable restrictions to the size of the communication device.

Moreover, the fact that the shape of the resonance chamber of a loudspeaker is of very little importance

with respect to the desired acoustic performance is exploited more or less fully.

When, as stated in claim 6, the at least one antenna is a coil or loop antenna, preferably a directive coil or loop antenna, a further advantageous embodiment of the invention has been achieved.

When, as stated in claim 7, the acoustic resonance chamber is a pressure chamber, it is possible to let the loudspeaker use the air located within the acoustic resonance volume as an elasticity, thus obtaining a better control over the loudspeaker. This provides a higher quality of the voice reproduction.

When, as stated in claim 8 the acoustic resonance chamber has acoustic openings to the exterior of the chamber it is possible to make a bass reflex system, which has a lower resonance frequency. This means that the system will have the ability to expand the frequency range downward with higher quality of the voice reproduction.

When, as stated in claim 9, the dimension of the acoustic resonance chamber totally or partly located within the electromagnetic resonance chamber is 0.5 to 8 cm3, a further advantageous embodiment of the invention has been achieved.

According to the above stated embodiment, typically a cellular phone, even minor reductions of volume are important and significant, as the designers of those

articles are heavily restricted by the need of reducing the volume to an "absolute" minimum.

However, it should be noted that the obtained reducing of volume in some devices of course may be much greater within the scope of the invention, if the devices for instance are fitted with more powerful loudspeakers. In case of an acoustic resonance chamber being of greater volume, an embodiment of the invention will benefit even more of the fact that there is very few constraints, if any, on the design of the shape of the resonance chamber.

When, as stated in claim 10 the shared resonance chamber inside being reinforced by reinforcement elements or walls dividing the chamber into smaller volumes it is possible to avoid problems with oscillations in the walls defining the chamber by using reinforcement elements.

Brief description of the drawing

The above and other objects, features and advantages of the present invention will become more apparent from the detailed description taken with the accompanying drawings in which:

Fig. 1 is a cross section of a conventional communication device with two separate resonance chambers.

Fig. 2 is a perspektiv view of a communication device according to the invention.

Fig. 3 is a view of a preferred embodiment of the connection between the loudspeaker and the resonance chamber.

Description of the invention

Referring to fig. 1 a conventional communication device comprises a housing containing various structural elements including the necessary elements of a cellular telephone such as a display, a keyboard, a battery (not displayed on fig. 1), a microphone, an antenna and a loudspeaker. The elements are mounted or connected to a printed circuit board (PCB) on which other necessary electronic components are mounted.

The communication device also comprises two volumes used as resonance chambers where the loudspeaker uses a first volume and another volume is used by the antenna. The chambers are separated by the PCB which extends in the entire length of the housing.

The resonance chamber is necessary to the loudspeaker because the front side of the loudspeaker membrane has to be somewhat isolated from the backside of the membrane to avoid acoustic short-circuiting between the sides of the membrane. The size of the volume inside the resonance chamber determines how low a frequency the loudspeaker can reproduce. It also determines how much power is necessary to obtain a desired sound intensity.

The resonance chamber is necessary to the antenna because it needs a dielectric volume to radiate the radio waves into from the active part of the antenna and down to a ground plane.

The distance between the active part of the antenna and the ground plan is at the same time a measure for how efficient the antenna is meaning the greater the distance the higher efficiency until a certain distance.

Now referring to fig. 2 a communication device according to the invention is displayed. The volume used by the antenna is at same time totally or partly defined by the antenna plane, which acts as walls for the chamber.

The loudspeaker is mounted in an opening in this plane of the antenna and has direct connection with the volume defined by the antenna.

An antenna of the kind used in the embodiment of the invention requires a relatively large amount of volume. To obtain satisfying performance of the antenna, the volume e.g. has to be larger than 13 cm3. Moreover, the loudspeaker needs a certain volume and preferably more than 4 cm3. The upper limited for the size of the volume is set by the size of the housing and normally no more than 50 cm3 of volume inside the housing should be utilised as the antenna volume and loudspeaker resonance chamber.

The antenna may preferably be a patch antenna. A dual band patch antenna would be another example of an application within the scope of the invention.

However, it should be noted that according to a further embodiment of the invention, the antenna means may comprise a conventional helix antenna mounted within the housing of the communication device.

Other examples of antennas that may be arranged within the housing of the device are coil and loop antennas.

It is understood that the shape and size of the resonance chamber can be altered from the displayed shape and size on fig. 2. The only thing that restricts shape and size of the resonance chamber is the housing in which it is incorporated.

In fig. 3 a preferred embodiment of the invention is displayed. To allow the loudspeaker to be placed in other positions than in direct contact with the resonance chamber an acoustic coupling is inserted between the loudspeaker and the resonance chamber.

It is understood that the shape and size of the acoustic coupling and the resonance chamber can be altered from the displayed shape and size on fig. 3.

CLAIMS

1. Communication device comprising a housing enclosing at least one loudspeaker and at least a part of at least one antenna inside the housing, said at least one loudspeaker comprising an acoustic resonance chamber and said at least one antenna comprising at least one electromagnetic resonance chamber,

characterised in that

the acoustic resonance chamber is totally or partly located within the electromagnetic resonance chamber.

2. Communication device according to claim 1, characterised in that the at least one antenna is a directive patch antenna.

3. Communication device according to claim 1 or 2, characterised in that at least one antenna is a dual band antenna.

4. Communication device according to the claims 1-3, characterised in that the at least one antenna totally or partly defines the walls of the acoustic resonance chamber.

5. Communication device according to the claims 1-4, characterised in that the loudspeaker is coupled to the resonance chamber by means of at least one acoustic channel.

6. Communication device according to the claims 1-5, characterised in that the at least one antenna is a coil or loop antenna, preferably a directive coil or loop antenna.

7. Communication device according to the claims 1-6, characterised in that the acoustic resonance chamber is a pressure chamber.

8. Communication device according to the claims 1-7, characterised in that the acoustic resonance chamber has acoustic openings to the exterior.

9. Communication device according to the claims 1-8, characterised in that the dimension of the acoustic resonance chamber totally or partly located within the electromagnetic resonance chamber is 0.5 to 8 cm3.

10. Communication device according to the claims 1-9, characterised in the shared resonance chamber inside being reinforced by reinforcement elements or walls dividing the chamber into smaller volumes.

Abstract

The invention relates to a communication device comprising a housing enclosing at least one loudspeaker and at least a part of at least one antenna inside the housing. This at least one loudspeaker comprising an acoustic resonance chamber and said at least one antenna comprising at least one electromagnetic resonance chamber.

The invention teaches that the acoustic resonance chamber can totally or partly be located within the electromagnetic resonance chamber.

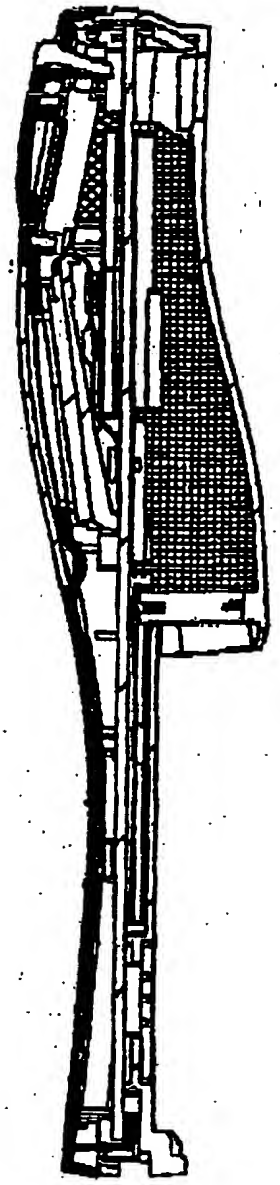

Fig. 1

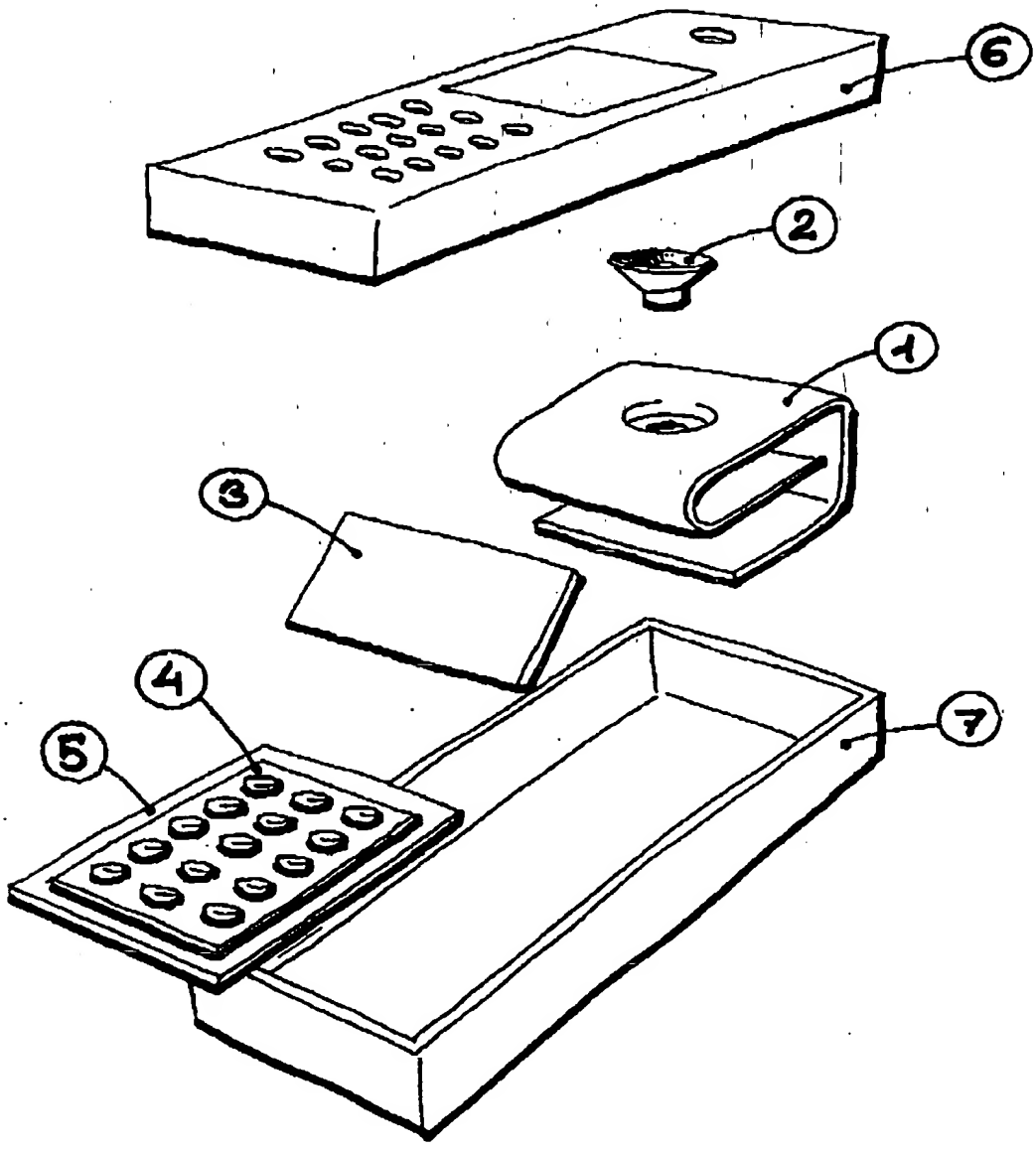

Fig. 2

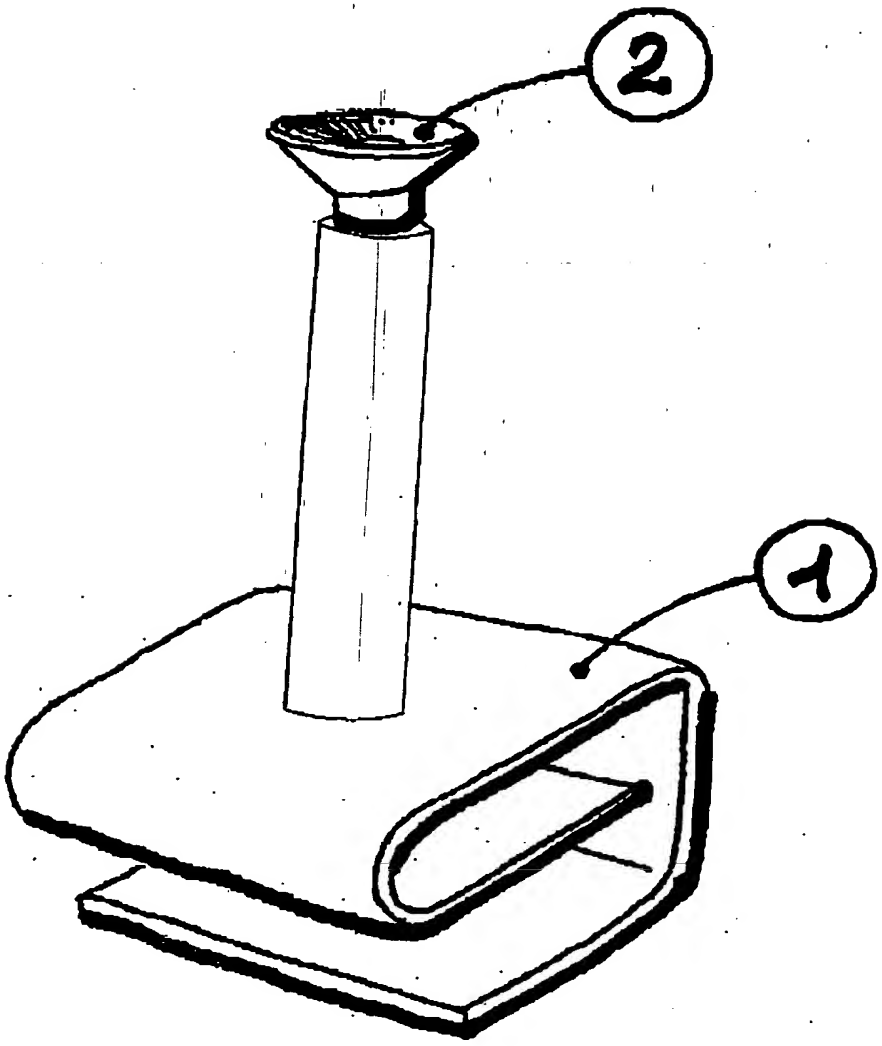

Fig. 3